Exotic physics

- Exotic group is structured as follows:
  - physics oriented subgroups:
    - SUSY (Song Ming Wang, Michael Schmitt)
    - Higgs (John Conway, Weiming Yao)
    - VEGy (Kaori Maeshima, Rocio Vilar)
  - technical subgroups
    - taus (Fedor Ratnikov, Alexei Safonov)
    - photons (Ray Culbertson, Beate Heinemann)
    - btag (Aaron Dominguez, Doug Glezinski)

Stephan Lammel
Steve Worm

Analysis Strategies

- Two different approaches strongly pushed on both sides

- **A) Traditional model driven analyses**
  - pick a favorite theoretical model pick a process, choose the best signature(s): optimize selection acceptances based on signal MC
  - calculate the expected background
  - evaluate the limit or discovery your signal

Useful at the beginning

☹ **might become soon outdated!**

☺ **best optimization!**

- **B) Signature based approach**
  - pick a specific signature (i.e. diphoton+X)
  - define your sample in terms of known processes
  - publish estimates of acceptances & cross section information useful for theorists
  - see an excess? Inconsistency with SM? Test one or more models later

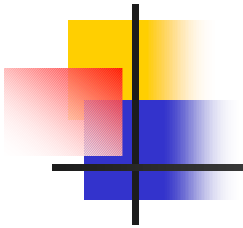
☹ **not best optimization but...**☺ **open to a whole lot of models!**

An unbiased study is fundamental for data understanding

Current status

- Several model based analysis ongoing:
  - Searches for mass bumps in DY spectrum
    - Z' and Randall-Sundrum graviton
  - Searches for mass bumps in the dijet spectrum
  - Searches for CHAMPS
  - New limits on Leptoquarks in the MET + jets channel and dielectrons + jets channel
- Signature based approach
  - physics involving photons

All at the stage of proto-analysis confirmation/updates of run I results



Current status (cont'd)

- Same concerns/issues as the Top group
  - No analysis involving b-tagging
  - Calorimeter understanding and simulation still a problem
  - very cumbersome data processing and access
  - general software problems
  - some datasets still being validated:
    - SUSY dileptons
    - MET

Where do the Italians fit?

- Higgs group :
  - Z -> bb
  - Higgs multijets (using) SVT trigger
  - MSSM Higgs (taus)

- For SM Higgs (WH/ZH, lvbb and vvbb channels) there is the need for
  - jet corrections,
  - dijet mass reconstruction
  - b tagging
  - background modeling

Covered in other subgroups

Higgs review commitee

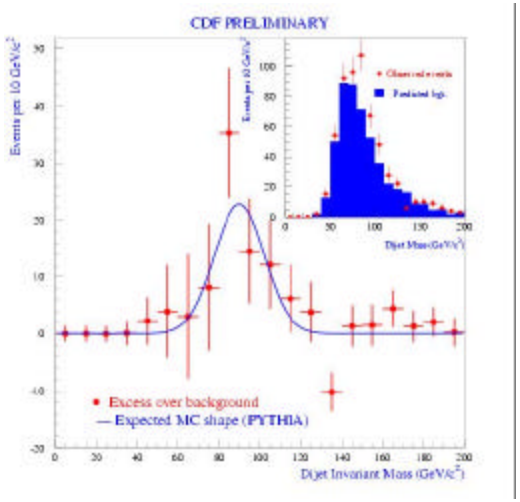
A committee has recently been formed and charged with making a re-evaluation of CDF's Standard Model Higgs search potential. This is motivated by a request made by the Director of DOE's Office of Science. The work of this committee will be closely coordinated with a parallel committee at D0 and the results will be combined to produce a Tevatron statement of the Higgs discovery potential in Run 2. In contrast to the projections done previously by a SUSY-Higgs Working Group, this report is expected to be blessed by the CDF and D0 Collaborations.

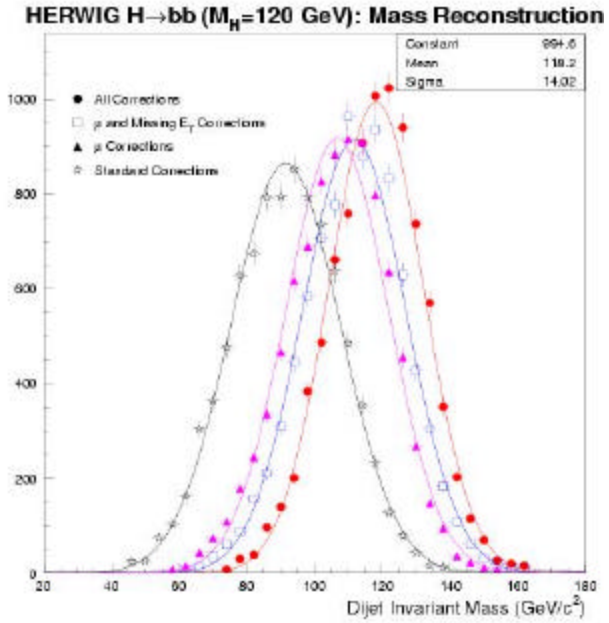
Timescale: June 2003

Good opportunity for contributions

Higgs searches at TeV II

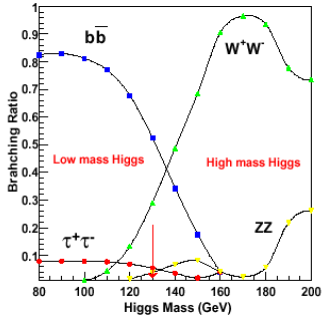
- Needed new tools
  - Jet energy resolution
    - supplementing calorimetry information with tracking and SMX should give a 30% improvements
    - The M_{bb} resolution can be improved up to 50%
      - $Z \rightarrow bb$ studies



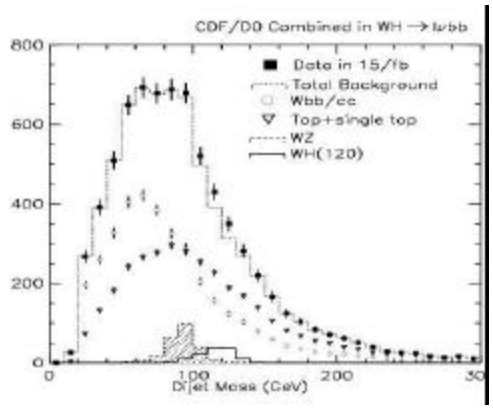


- b-tagging techniques
- SVT allow for a sample enriched in HF
- offline b-tag could benefit from 3D Si-tracking to reduce mistags
- loose tagging techniques still viable (SLT, JPB)

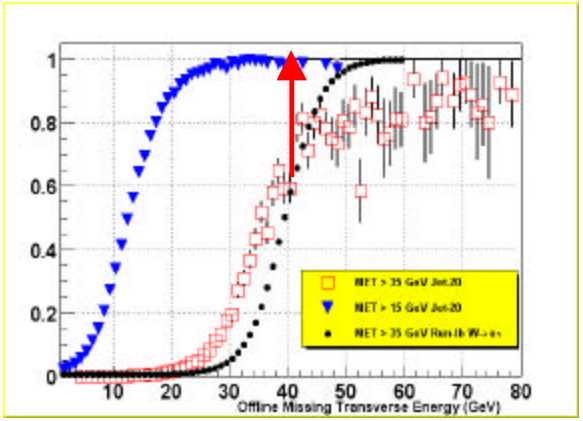
The quest for Higgs at run II



- Higgs production and decay
  - $gg \rightarrow H$ dominates over all mass ranges, but huge QCD backgrounds.
  - $M_H < 130$ GeV/c^2 "Low mass Higgs".
    - $H \rightarrow bb$ with Associated production mode is the most promising. The double b-tagging together with the signature of the additional boson helps to discriminate from the background.

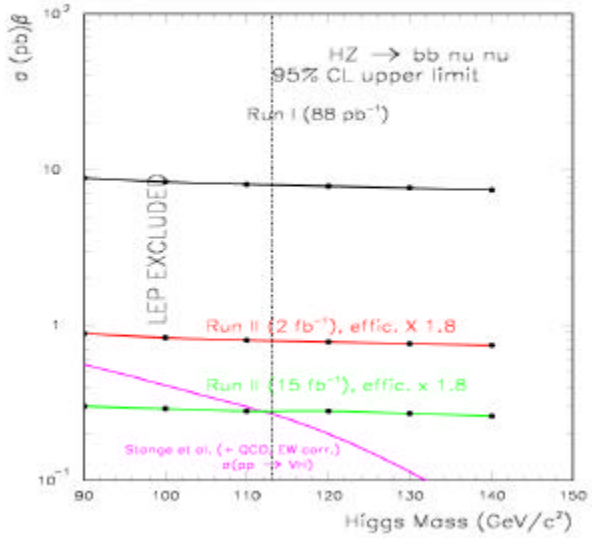


- Trigger strategies
  - SVT to select a sample enriched in heavy flavors
  - qqbb, MET + bb



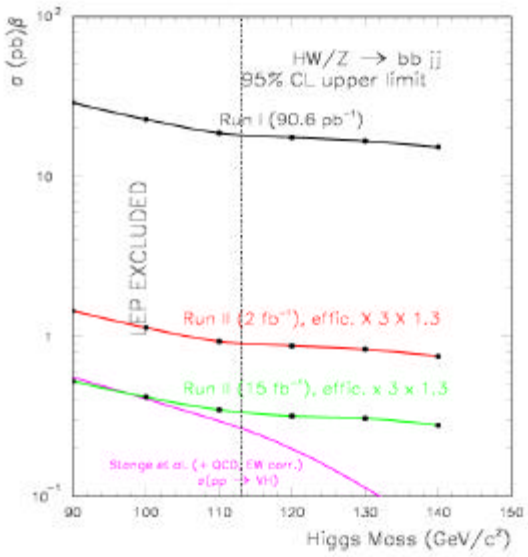
With MET>15 the Turn-on plateau is reach for $MET^{offline}$ >30 GeV For cuts $MET^{offline}$>40 an efficiency increase of **1.4** can be reached in respect to run I.

Run II extrapolations



MET + bb:
In respect to run I, factor 1.4 (turn-on) x 1.3.
(improved geometrical acceptance)

Multijets:
in respect to runI factor 3
(double b-tag efficiency)x1.3.

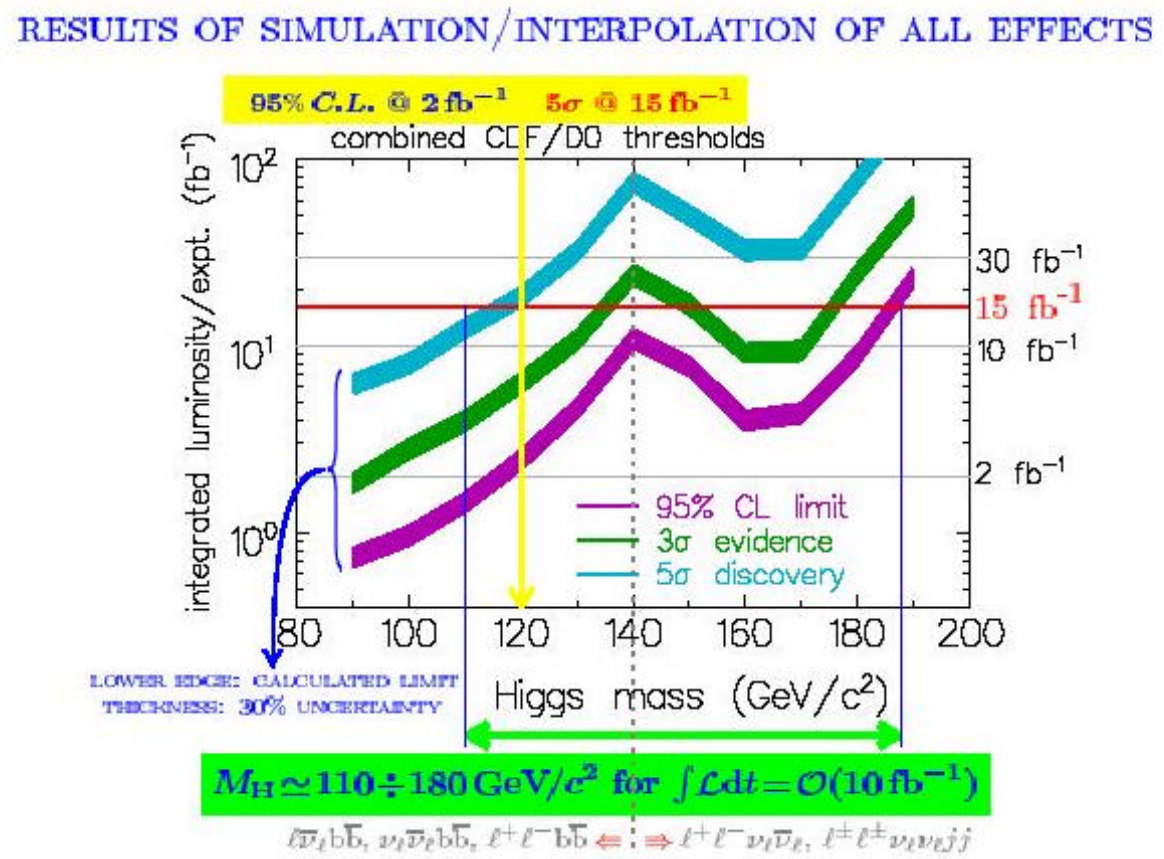


- Assuming the same Signal to Background ratio as in RUN-I, the cross section limit at 95 % confidence level has been scaled as

$$Eff_{RI} / Eff_{RII} \times \sqrt{(L_{R-I} / L_{R-II})}$$

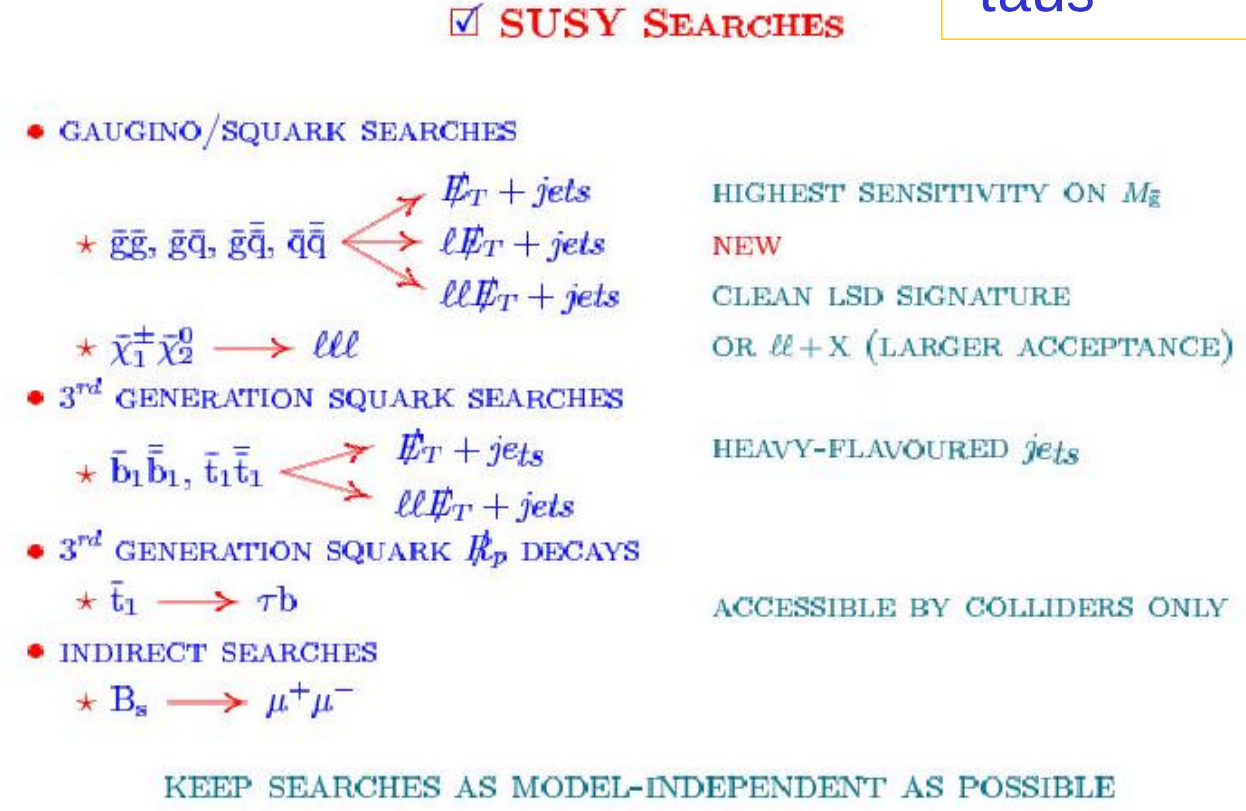
Run II SM Higgs sensitivity

To be revised
or confirmed?



SUSY

Heavy flavor jets
MET
taus



SUSY squarks and gluinos

☑ SQUARK/GLUINO PAIR → $\not\!\!E_T + jets$

★ $\tilde{g}, \tilde{q}$ HADRONIC DECAYS, $\not\!\!E_T$ FROM LSPs

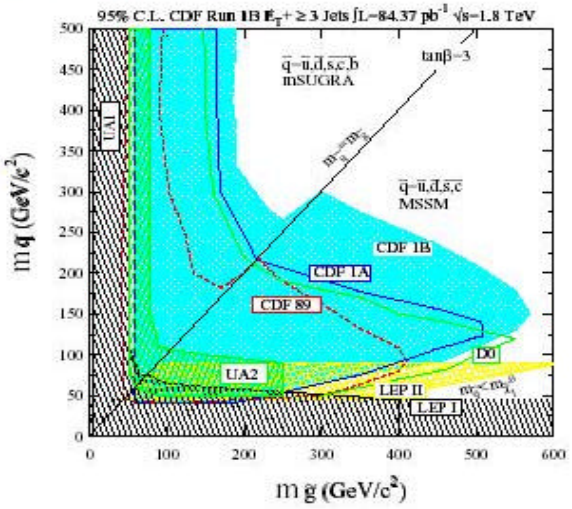
⇝ $\geqslant 3$ JETS, LARGE $\not\!\!E_T$

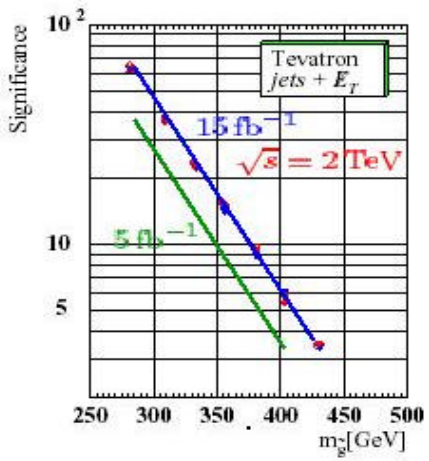
⇝ MAIN BACKGROUNDS: QCD, $V + jets$, $t\bar{t}$

⇝ RUN I 95% *C.L.* EXCLUSION REGION →

→ $M_{\tilde{g}} < 195\,\mathrm{GeV}/c^2$ FOR ANY $M_{\tilde{q}}$

→ $M_{\tilde{g}} < 300\,\mathrm{GeV}/c^2$ FOR $M_{\tilde{g}} \simeq M_{\tilde{q}}$





RUN II EXTRAPOLATION ($M_{\tilde{g}} \simeq M_{\tilde{q}}$)

→ SIGNIFICANCE INDEPENDENT OF $\tan\beta$

→ LINEAR WRT $M_{\tilde{g}}$

→ 5σ REACH @ $5\,\mathrm{fb}^{-1}$: $M_{\tilde{g}} \simeq 380\,\mathrm{GeV}/c^2$

→ NEED $W + jets$ FOR $\ell\not\!\!E_T + jets$

MARIO PAOLO GIORDANI 20

Stop and sbottom

☑ 3rd GENERATION SQUARKS: $\tilde{b}_1\bar{\tilde{b}}_1 \rightarrow \not{E}_T + jets$

★ ASSUME $B.R.(\tilde{b}_1 \rightarrow b\tilde{\chi}_1^0) = 1$

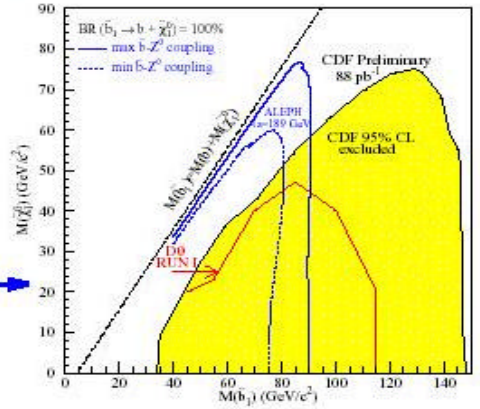
⇝ 2 JETS, LARGE $\not{E}_T$

⇝ LEPTON VETO

⇝ $\geqslant 1$ b-TAGGED JET (JPROB)

⇝ MAIN BACKGROUNDS: QCD, V + *jets*, $t\bar{t}$

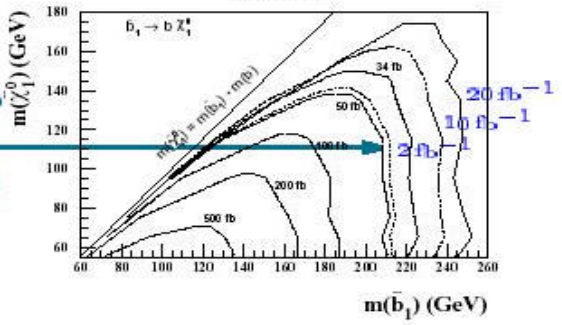
⇝ RUN I 95% *C.L.* EXCLUSION REGION → $M_{\tilde{b}_1}^{max} < 148\,\mathrm{GeV}/c^2$



RUN II EXTRAPOLATION

→ 95% *C.L.* EXCLUSION REGION @ $2\,\mathrm{fb}^{-1}$ UP TO $M_{\tilde{b}_1} \simeq 215\,\mathrm{GeV}/c^2$

→ 3σ REACH @ $4\,\mathrm{fb}^{-1}$ UP TO $M_{\tilde{b}_1} \simeq 110\,\mathrm{GeV}/c^2$



Stop in SS dileptons

☑ 3^{rd} GENERATION SQUARKS: $\tilde{t}_1\bar{\tilde{t}}_1 \rightarrow \ell\ell\not{E}_T + jets$

★ ASSUME $B.R.(\bar{t}_1 \rightarrow \ell^+ b\bar{\nu}_\ell) = 1$

⇝ $\ell^+\ell^-$ (ℓ=e, μ) ISOLATED PAIR

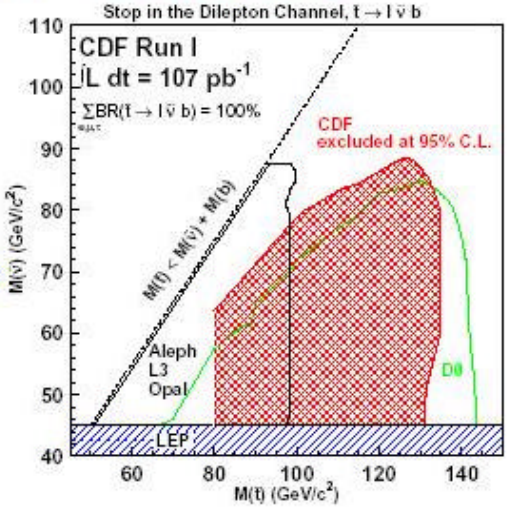
⇝ $\geqslant 1$ JET AND SIGNIFICATIVE $\not{E}_T$

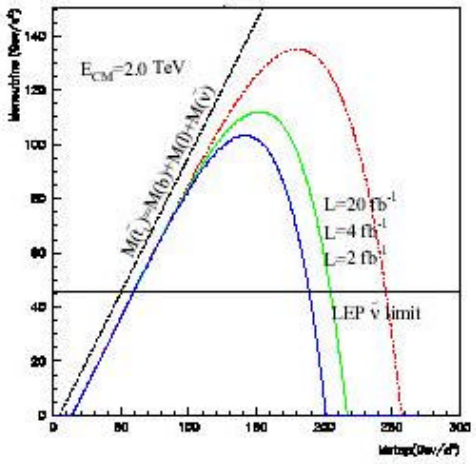
⇝ MAIN BACKGROUNDS: $t\bar{t}$, $b\bar{b}/c\bar{c}$, VV, DY

⇝ RUN I 95% *C.L.* EXCLUSION REGION →

→ $M_{\tilde{t}_1}^{max} < 135\,GeV/c^2$

→ $M_{\tilde{b}}^{max} < 88.4\,GeV/c^2$





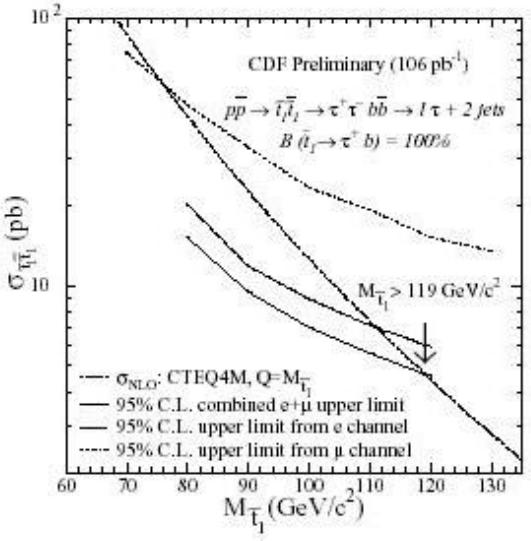
RUN II EXTRAPOLATION

→ 3σ SENSITIVITY @ $2\,fb^{-1}$ UP TO $M_{\tilde{t}_1} \simeq 190\,GeV/c^2$

Stop and taus

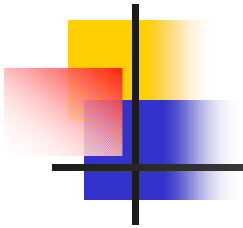
☑ 3rd GENERATION SQUARKS: $\not R_p$ $\tilde{t}_1\bar{\tilde{t}}_1$ DECAY

- ★ ASSUME $\not R_p$ IN 3rd GENERATION ONLY
- ★ ASSUME $B.R.(\tilde{t}_1 \to \tau^+ b) = 1$
- ★ CONSIDER $\ell\tau_{had}b\bar{b}$ (ℓ=e, μ) FINAL STATE
  - ⇝ ISOLATED LEPTON
  - ⇝ $\geqslant 2$ JETS
  - ⇝ τ_{had} → ISOLATED TRACK+E_{had} / NARROW CLUSTERS
  - ⇝ BACKGROUNDS: QCD, V + *jets*, Z→ττ
  - ⇝ RUN I 95% *C.L.* EXCLUSION REGION
    - → $M^{max}_{\tilde{t}_1 \not R_p} < 119\,\mathrm{GeV}/c^2$
    - (e AND μ CHANNELS COMBINED)



Some remarks on SUSY searches

- With direct searches is possible to probe SUSY existence in a good mass range
- on the other hand direct searches are limited by the final integrated luminosity and $\sqrt{s}$
- Also, we need to constrain somehow SUSY
  - very limited reach is left in MSUGRA (LEP exhausted almost all)
  - at FNAL theorists are working on new benchmarks scenario
  - possible connections with Italian theorists?
  - Constraints are in general model-dependent.....



Conclusions

- The exotic group is starting producing results from run II data
  - most of them are confirmations/updates of run I results
    - limited by statistics and LEP final results
- Lots of work needs to be done in terms of understanding the detector before claiming new physics
  - MET for all
- common topics with high pt top/ew group